

Tannin-containing forage crops: A way to improve nitrogen use and profitability of dairy farms?

What are tannins?

- Condensed tannins are phenolic compounds that bind to protein under neutral to slightly acidic pH conditions.
- Tannins are abundant in leaves of many woody plants. Low to high concentrations of tannin, 0.5 to 10% on a dry matter (DM) basis, are found in some forage and grain crops (e.g. trefoils, sainfoin, lespedeza, grain sorghum).
- Tannins may protect plants from pests. High concentrations of tannin (> 6% DM) reduce feed palatability and nutrient availability.
- The major feeds used on U.S. dairy farms (alfalfa, corn silage, forage grasses, corn grain, soybean, etc) have very low levels of tannin (< 0.2% DM).

Potential benefits of tannins

- Moderate amounts of tannin (1 to 3% DM) reduce protein loss during ensiling and ruminal fermentation of forages. As a result, livestock fed tannin-containing forages may need less protein supplementation to reach optimal production. In a recent New Zealand study, non-supplemented Holstein cows fed fresh birdsfoot trefoil with 2.5% tannin produced 6 lbs more milk per day than cows fed birdsfoot trefoil with inactivated tannins. Tannin-containing forages have not been evaluated in complete dairy rations.
- When livestock are feed tannin-rich feeds, nitrogen in manure is extremely stable. High concentrations of tannin also slow the release of nitrogen from crop residues in soil. It is not known whether moderate amounts of tannin could improve manure and crop residues as "time-release" nitrogen fertilizers.

Impact of forage tannins on U.S. dairy farms: A preliminary assessment

Plant breeding and biotechnology efforts are underway in the U.S. and abroad to develop alfalfa and other forages with moderate tannin levels. We used a dairy farm simulation model (DAFOSYM) to predict the impact of growing and feeding an alfalfa with 1 to 2% tannin on a dairy farm in Southern Wisconsin. The farm had 100 cows and 85 replacement heifers on 250 acres of a medium silt loam soil. In this analysis, similar amounts of alfalfa silage (550 tons DM), corn silage (280 tons DM), and corn grain (170 tons DM) were produced and fed when normal or tannin-containing alfalfas were used. Additional results are summarized below.

	Unit	Normal alfalfa	Tannin-alfalfa
Soybean meal, 44% purchased	ton DM	58	37
Roasted soybeans purchased	ton DM	64	12
Corn grain purchased	ton DM	33	110
Fat purchased	ton DM	6	7
Average milk production	lbs/cow	24,700	25,400
Net return	\$/cow	1,680	1,830
Nitrate and ammonia loss from farm	lb/acre	96	71
Average nitrate in soil leachate	ppm	13.4	9.1

In this example, feeding a tannin-containing alfalfa to 100 cows and 85 heifers reduced protein supplement purchases by 73 tons/year and nitrogen losses by 25%, and increased farm profitability by \$15,000 per year. Feeding tannin-containing alfalfa shifted grain purchases from roasted soybeans to corn. Since corn is higher yielding than soybeans, 30% less land (20 acres) on other farms would be needed to supply the feed grain needs of a dairy feeding tannin-containing alfalfa.

Current and future research

Over the next five years, we will use birdsfoot trefoil varieties with 0.5 to 4% tannin and alfalfa to study the impact of forage tannins on...

- Milk production of dairy cattle fed conserved forage or pasture
- Protein and energy supplementation of dairy cattle
- Nitrogen loss from manure during excretion, storage, and land application
- Nitrogen use and loss from manure and crop residues in crop rotations

These studies will help us to identify optimal tannin concentrations and management practices for improving protein and nitrogen use on dairy farms. Our findings will be incorporated into DAFOSYM and other models to more accurately predict how tannins will affect dairy farms in different regions of the U.S. Our studies will also assist plant breeding and biotechnology efforts in the U.S. and abroad aimed at developing improved tannin-containing forages.

John Grabber¹, Glen Broderick¹, Michael Russelle¹, Mark Powell¹, Al Rotz², Richard Muck¹, Dave Mertens¹, and Lee Massingill¹

¹US Dairy Forage Research Center, 1925 Linden Drive West, Madison, WI

²Pasture Systems and Watershed Management Research Lab, Curtin Rd., University Park, PA

For further information, contact John Grabber at 608-264-5820 or jgrabber@facstaff.wisc.edu